Research and Development Activities with EOS Aura Products

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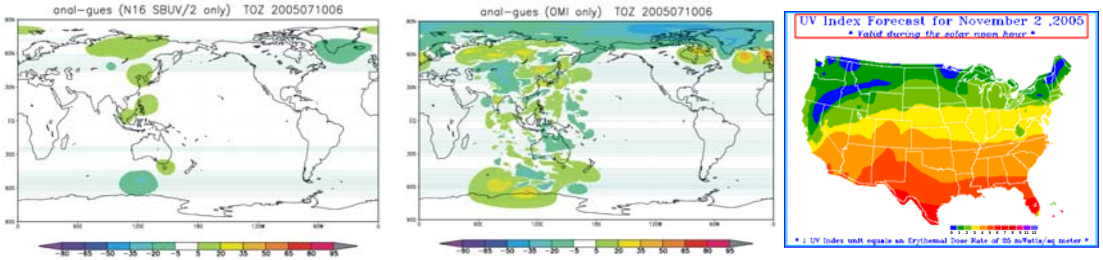
Introduction

The EOS Aura instruments are producing high quality measurements that can be used in pseudo-operational applications and for the development and demonstration of improved products and assimilation methods. Within NOAA, researchers are currently or soon will be working with EOS Aura products in the following areas: the assimilation of ozone products into numerical weather models, the development of ozone profile and other trace gas retrieval algorithms for use with future operational instruments, the development and validation of air quality models and forecasts, the improvement of UV Index forecasts, and the addition of new resources for hazard identification and ozone layer and ozone hole monitoring. This poster gives additional information on these applications and describes some of our research goals, activities and plans.

Assimilation

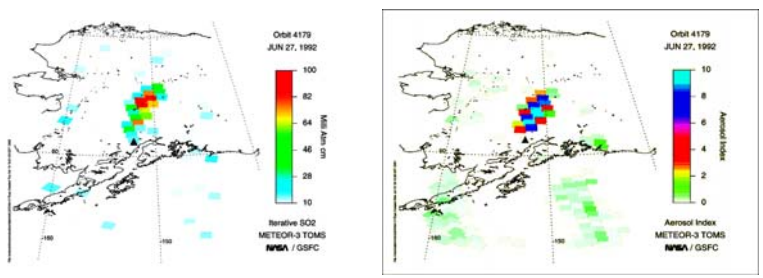
We are assimilating MLS ozone profiles and OMI total ozone products into numerical weather models in a research mode. In the future, this study will be extended to a full demonstration by using the near-real-time products of opportunity from OMI and HIRDLS. The total ozone products provide a much denser set of inputs than the current operational SBUV/2 nadir products. Figures 1 and 2 are focused on the assimilation part only. They show the changes from assimilating four orbits of SBUV/2 total ozone data versus the changes from assimilating four orbits of OMI total ozone data. The dense OMI data allows for better internal quality control. Forecast experiments are ongoing via a quasi-parallel run of assimilation and forecast using OMI TOZ. We will compare the output with NCEP operational products (control run) to see the impact of assimilating OMI TOZ on the model's performance, such as in the forecast of temperature, wind, etc. through changes in atmospheric heating. The assimilated and forecast ozone fields also have applications in correcting infrared and visible sounding channels sensitive to ozone absorption and emission prior to their use in estimating atmospheric and sea surface temperatures.



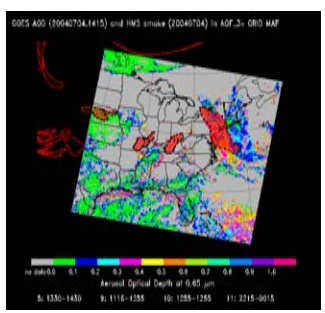
Figures 1 and 2. Changes in analysis for assimilation of four orbits of data

Volcanic Hazards, Smoke and Fires

At times during NASA TOMS missions, NOAA has obtained rapid delivery of TOMS Level 1 data and run the standard total ozone retrieval algorithms to produce total ozone, aerosol index and SO2 index data products in near-real-time for volcanic hazard identification. The near-real-time OMI product system is capable of providing similar products of opportunity, and we have entered discussions with NASA and KNMI to obtain these valuable products. As is the case for the ozone products, experiences in creating these products and access to them through normal distributions channels are helping us to prepare for GOME-2 and OMPS operational products. There is an additional NASA-funded effort to develop algorithms to create even better volcanic SO2 and ash products from EOS Aura for these applications. (Note a related talk by N. Krotkov on Wednesday morning.)
The NOAA Hazard Mapping System provides smoke analysis products using fire locations and visible imagery from operational geostationary and polar-orbiting satellites. When smoke is removed from source and mixed in with other aerosols, it becomes difficult to differentiate between smoke plumes and other features. We plan to use the OMI near-real-time aerosol index product to help analysts differentiate between the two. In the image below on the right an analyst has drawn smoke plume polygons (in red) overlaid on top of GOES aerosol optical depth (AOD) product contours.



Figures 3 and 4. SO2 and Aerosol Index for Mt. Spurr Eruption.



Operational Ozone Product Validation and Algorithm Development

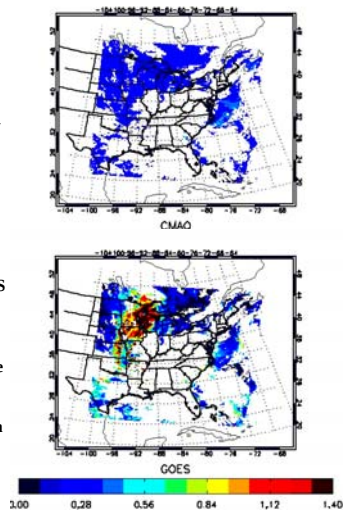
We are comparing EOS Aura ozone products to our operational total and profile ozone products from SBUV/2 instruments on NOAA-16, -17 and -18. A separate poster at this session shows some of these results. We are benefiting from the lessons learned during application of the Version 8 total ozone algorithm to OMI in our work to implement and adapt that algorithm for use with GOME-2 measurements beginning next year. Using the Version 8 SBUV/2 ozone profile retrieval code as a starting point, we are implementing changes so that the profile algorithm can make retrievals for off-nadir satellite view angles using an arbitrary number of channels with channel-dependent slit functions. This algorithm will be demonstrated once OMI Level 1B products are publicly released. We plan to use it in the future with operational backscattered ultraviolet instruments – GOME-2 on MetOP and OMPS on NPOESS. Similarly, the NPOESS OMPS total ozone algorithm will be tested by generating retrievals for proxy data sets created from OMI measurements.

Improving Air Quality Monitoring and Forecasting

NOAA's National Weather Service has a mandate to issue nationwide hourly ozone (by 2009) and PM2.5 forecasts (by 2014). The NWS has already begun issuing ozone forecasts for the northeast and conducting experimental PM2.5 forecasts using an air quality modeling system (CMAQ – Community Multi-scale Air Quality Model) developed by the EPA. Primary sources of uncertainties in model forecasts are from uncertainties in initial and boundary conditions and emissions. We plan to use Aura trace gas and aerosol data to:

- **Verify air quality forecasts**
- **Diagnose sources of uncertainties (e.g., in emission estimates)**
- **Assimilate and improve initial and boundary conditions in the models (e.g., long range transport of dust)**
- **Study radiative effects of aerosols**

The Figures to the right show a comparison of NCEP's July 17, 2004 17Z aerosol optical depth forecast (top panel) with observations made by the GOES Imager (bottom panel). This event was dominated by the long-range transport of smoke from fires burning in Alaska/Canada. The high optical depth values observed by the GOES Imager were not accurately forecast in the regional model because of its static lateral boundary conditions. Assimilation of satellite data will improve forecasts in scenarios such as these.
Aura data will allow us to demonstrate that satellite data have tremendous potential in improving air quality monitoring and forecasting. Experience with Aura products and the development of various air quality analysis tools will prepare us for similar products derived from MetOP GOME-2 instruments.



Conclusions and Credits

EOS Aura is following in the heritage or Terra and Aqua in advancing operational systems with multifaceted science-to-operations applications. The high-quality and good-coverage EOS Aura products are helping NOAA to prepare for operational products from MetOP GOME-2 and NPOESS OMPS.

Credits for Figures from Websites:

UV Index Figure from http://www.epa.gov/sunwise/uvindexcontour.html
Ozone Hole Figures from http://www.cpc.ncep.noaa.gov/products/stratosphere/polar/polar.shtml
Mt Spurr Alaska SO2 and Aerosol Index Figures from http://toms.umbc.edu/